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CONTROL OF TOMATO SEEDBED DISEASES OF SOUTHERN PLANTS

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THE CONTROL OF TOMATO SEEDBED DISEASES OF SOUTHERN PLANTS

INTRODUCTION

Heretofore experimental work done on the control of tomato seedbed diseases has dealt with conditions in hot beds and cold frames. Disinfection of the soil, walls of the beds, cleaning out the beds and supplying new soil, etc., have been part of the control methods. In hot beds and cold frames there is usually a plentiful supply of moisture resulting in great attention being paid to damping-off control, and seed treatments often have this end in view.

With the rise of a new plant culture in the South, new and different problems were presented. Plants were grown in large fields of five to 80 acres or more, the seed being drilled in rows like wheat. There was no possibility of sterilizing the soil. Instead of changing the soil, the crop was changed. Damping-off was practically unknown. The wide expanse of the fields and the use of horse-drawn cultivators favored the spread of diseases on a large scale. On the other hand, the complete exposure of the plants to the weather and the dry sun and air of April and May acted as a very effective check on the spread of diseases. Seed treatments, satisfactory under hot bed and cold frame conditions, sometimes proved unsatisfactory. The power drawn power sprayer, covering many rows at a time, has found its way into the plant bed presenting many new problems.

HISTORICAL

According to statements of plant men the tomato plant business seems to have begun on a commercial scale in south Georgia in 1914 when the old Royal Packing Company of Indiana (now out of business) shipped in something like 1,700 pounds of tomato seed and arranged with several farmers about Tifton to grow plants for them. Plants had been grown in Florida but the season there was too early for Indiana planting. Among the growers planting seed that year were J. T. Davis, Paul Fulwood, Jim Davis (of present Davis Plant Company), and Howard Davis. Most of the growers had no experience in growing tomato plants and a late cold spell caused much damage, so that they had little success.

In 1916 and 1917 Bert C. Keithley came from Indiana and arranged for the growing of tomato plants in an experimental way. His aim was to lengthen the tomato season in Indiana with early hardened plants and thus widen the market for his plants. In 1918

Mr. Keithley made contracts for the growing of tomato plants about Tifton on a rather extensive scale. This is considered to be the real beginning of the tomato plant business on a successful commercial scale.

In the 20 years since its beginning the tomato plant business in south Georgia has grown to sizable proportions. In 1934 between 2,200 and 2,500 acres were planted, the seed used being counted in tons. Estimates of shipments range from 125 million to 200 million plants but it is probable that 150 million is approximately correct. This number of plants would have set the entire 1929 market acreage of Indiana, which is the second largest tomato growing state in the Union, with enough left over to have supplied all of the New England states, furnished enough plants for Minnesota, and made it unnecessary for the market growers of the District of Columbia to have raised a single tomato plant in hot beds or cold frames.

THE EXCUSE FOR THE SOUTHERN TOMATO PLANT

At first thought it would appear that no more ideal arrangement could be had than the growing of tomato plants in the early spring of the South, where they need no hot beds, no steam heat and no artificial covering or protection from cold, and the sending of nice outdoor grown plants, completely hardened, to northern states to be set out at the earliest possible moment. However, some difficulties have developed.

In the early years of the business southern plant men knew nothing about diseases and apparently the northern seed growers knew little more. The bulk of the seed was, as at present, furnished by canners and other firms in the North on contract, the southern farmer growing the plants at a stated price per thousand. Apparently little or no seed treatment was practiced and spraying was done only to control insects when they became numerous. Adverse comment in the northern agricultural press soon became frequent. In New Jersey (21) "many growers were disappointed with disease and collar rot coming in on southern grown plants." In Indiana (6) tomato growers were warned that "these plants should be used with care. It is not always possible to distinguish healthy from diseased tomato plants and for this reason plant growing in southern states should be under the supervision of persons able to select soil free from disease and insect pests." In Maryland (14) it was noted that "bacterial canker occurred to a limited extent in the sections using southern plants." In New York (9), "the northern grower" was told that he "should not buy southern seedlings unless a guarantee of health can be obtained for them." However, the Market Growers Journal (18) remarks that, "Southern grown

plants for early northern crops are perhaps the main reliance of thousands of growers in many states. The shipments of these plants are now of large proportions annually." Indeed, so great has been the demand for southern plants that some plant growers have questioned the need of disease control to increase the demand.

In reply to the criticism in the North the southern plant growers maintained that the diseases came first from the North on the seed and that the South had no important diseases that were not found in the North. The same diseases were being distributed from local northern plant beds. The local market grower who finds that his crop failure is traced back to his own plant beds naturally does not complain as loudly as when it is traced to plants grown by someone else. The transportation of diseases on plants from the South was made more noticeable by the centralization of the plantings and the wide distribution of the shipments. In fact, it would appear that there is less chance of initial infection of plant beds occurring in the South than in the North considering Georgia's small market acreage (10) of 3,752 against Maryland's 55,955, Indiana's 43,359, New Jersey's 41,860, New York's 18,031, and Delaware's 15,460 acres. Furthermore market production of tomatoes in Georgia is more or less localized, comparatively little being grown in the plant-producing sections. It is reasonable to suppose that in areas of heavy market production there would be much greater danger from contaminated soil in plant beds than in the cotton growing South.

Seeking an answer to the disturbing question of seedbed disease source and control, Boyd (5) in 1929 in cooperation with the New Jersey (20) and Delaware (15) Experiment Stations secured 42 sample lots of seed from the planting stocks of the growers and planted these in experimental plots in soil that had not previously grown tomatoes, sending plants to Delaware and New Jersey. Diseases which developed in the seed bed and in the plots set with plants from the seed bed included Early Blight (*Macrosporium solani* E. & M.), Nail Head blight (*M. tomato* Cooke), Bacterial spot (Bact. *vesicatorium* Doidge), Bacterial canker (*Aplanobacter michiganense* E. F. S.), and Septoria leaf spot. All lots showed some infection by one or more of these diseases, some with only a trace while others were heavily infected. It was observed by Manns (15), "The evidence is quite clear that some of these diseases are carried directly on the seed," and by Boyd (5) that "there was observed a direct relation between the kind and severity of diseases in the commercial can-crop fields and seed-stock fields of the northern states, and the diseases that appeared in southern plants grown from seed saved in those sections the preceding year."

So great is the need of the northern can-house and market grower, and the southern plant specialist for each other that it is to the

interest of both to cooperate to the fullest extent in solving the problem of disease control both in the southern plant fields and in the northern seed crop fields. The northern grower gets outdoor hardened plants approximately two weeks earlier than he can get home grown plants and as a rule he pays much less for the southern plants.

Lengthening the season at the beginning adds tons to yields. From a survey in Maryland Goodwin (11) found a gradual decrease in yield as the planting date was delayed, the decrease amounting to 2.5 tons per acre as between fields set May 20 or before and those set June 10 or later. In New Jersey Crancross and Nissley (8) found that "Under normal weather conditions tomato plants set in the field May 25 or before have given a larger yield by at least two tons to the acre over June set plants."

SOME SEEDBED DISEASES

It is proposed to discuss only a few of the more important tomato seedbed diseases found in Georgia in order to clarify and explain disease control measures and the reasons behind these measures.

MACROSPORIUM BLIGHT. Perhaps the disease most frequently observed, at least in the South, is Macrosporium blight. At least two organisms, *M. solani* E. & M. and *M. tomato*, Cooke, are concerned in producing this disease but for practical control purposes they may be considered as one disease since their symptoms and progress on the plant are similar. This disease produces more or less circular dark brown to nearly black spots, usually with concentric circles, on the stems, leaves, and fruit. When spots occur on stems of plants near the ground they sometimes girdle the plant. This effect is called collar rot. When fruit is gathered from heavily diseased plants many of the fungus spores may be lodged on the surface of the fruit or carried on spotted fruits and when this fruit is crushed and the seed taken out some spores become lodged among the hairs on the surface of seeds. When the seed is planted the fungus spores may germinate at the same time with the seed and infect the first two smooth leaves. From these first spots spores are produced and scattered by wind, cultivating tools, or by splashing raindrops to other plants where new centers of spread are initiated. It also attacks other related plants such as Irish potato, eggplant, etc.

Since this fungus may live on decayed plant material in the soil it is capable of holding over in the soil at least until the following season. Under these conditions even perfectly clean and healthy seed may produce diseased plants if grown where diseased plants have grown the season before. Besides these two methods of spread, the seed and the soil, a third is sometimes important, which is by

air currents and winds carrying spores from a diseased field to surrounding ones.

BACTERIAL CANKER. Not so common in tomato fields but very much more feared than Macrosporium blight is the disease known as bacterial canker caused by *Aplanobacter michiganese* E. F. S. So destructive is this disease that states which certify tomato seed have in their regulations statements that, "No tolerance is allowed for bacterial canker," "Fields showing bacterial canker will be rejected," "No field shall be accepted for certification in which bacterial canker is found at the time of the second inspection," etc.

This disease causes a wilting and death of the leaves on one side of the midrib, cankers on the stems and sometimes small spots on the leaves and fruit. The bacteria causing the trouble are carried on the surface of the seed and even inside the seed. It is apparent that the treatment of the outside of the seed with disinfectants can not destroy the infection on the inside.

A study of the literature on this disease reveals the need for controlled long-time experiments on its ability to live from season to season in the soil under normal field conditions both in the South and in the North. Several workers have stated that this disease is carried over from season to season in the soil but there is little actual experimental data published. Blood and Walker (3) state that "The parasite overwinters either with the seed or in the soil of the seedbed, or in the field," giving no data. Blood (1) further states that, "In the absence of severe meteorological disturbances higher percentages of infection usually result from infected seed than from clean seed planted in infected seedbed soil or from healthy seedlings planted in infested field soil." Bryan (7) has recorded the survival of the bacteria, causing this disease, in dry soil protected in the laboratory for two and one-half years. However, when she inoculated soil outdoors in the fall the disease failed to develop on tomatoes set in it the following spring. She records instances from observations in commercial fields of tomatoes indicating both total lack of carry-over in the soil and severe infection of crops set in fields the season following heavy losses from bacterial canker. In Ohio, Williams (22) found that, "In three separate tests of its ability to remain alive in greenhouse soil for several months, only negative results were obtained." In New Jersey, Martin (19) set healthy plants in ground where tomatoes died of bacterial canker the year before and got no infection. Blood and Wann (4) state, "Overwintering studies continue to yield evidence of the ability of the bacterial canker organism to survive the winter and induce the disease the following season under Utah conditions."

In 1932, in connection with the prosecution of the spraying experiments recorded in this bulletin it was found that plants pulled

from the check plot and shipped north developed bacterial canker. At the request of Mary K. Bryan of the Bureau of Plant Industry, this same check plot was planted again in 1933 with clean Marglobe seed furnished by her. Plants from this plot were sent to Miss Bryan at Washington, D. C., and some were set out at Tifton. At Washington they were grown both in the field and in the greenhouse. No sign of bacterial canker was observed either at Washington or in south Georgia, even in the seedbed which was kept under observation most of the season. Some of the same lot of seed was planted in another field, not known to have ever grown tomatoes, being part of our 1933 experiment, and produced only clean plants.

In a further test of carry-over of bacterial canker in the soil, cultures of the canker organism were secured from Miss Bryan in 1933 and seedlings of the Break O'Day variety inoculated by dipping their roots in a water suspension of the bacteria. These plants were set in a small isolated plot at Tifton. Within less than a month there appeared to be practically 100 per cent infection by bacterial canker in the plot. These plants were allowed to die on the ground, which was not used until the next spring when it was plowed and planted to clean Marglobe tomato seed. This plot was kept under observation during the season of 1934 and although Macrosporium blight and southern root rot were plentiful and there was a trace of Fusarium wilt, no symptoms of bacterial canker could be found. Since some workers have found that this disease sometimes carries over in the soil it is apparent that crop rotation is a necessary control measure for this disease.

BACTERIAL SPOT. Bacterial spot caused by *Bacterium vesicatorium* Doidge is a disease sometimes found on southern plants. It produces small water-soaked to brown or black spots on the leaves, stems, and fruits. The bacteria may be carried on the seeds and has been found to overwinter in the soil. On the seed it is easily controlled by seed treatment. It is sometimes a very serious disease, especially during a wet season, defoliating the plants and spotting the fruits so that they are unmarketable. It is also serious on pepper.

FUSARIUM WILT. Fusarium wilt is widely distributed in practically all sections of the United States growing tomatoes but is most destructive from about the latitude of the Ohio Valley states southward. The fungus, *Fusarium lycopersici* Sacc. attacks the plant from the soil, entering the roots and spreading by the water-conducting system into the aboveground parts of the plant and causing a browning of the vascular tissues. It produces a yellowing and wilting of the plant, which is usually more or less gradual and successive from the lower leaves upward. The majority of diseased plants, unless infected late in the season, are stunted and die before

the end of the season. The Fusarium fungus can remain alive in the soil for an indefinite period but a three or four-year rotation greatly reduces the seriousness of the disease. While seed treatment will usually prevent the spread of this disease with the seed, it is of little value where the disease is already established. Breeding for wilt resistance is the main reliance for the control of this disease and a number of resistant varieties have been developed, the Marglobe being the one most extensively grown.

BROWN ROT. Bacterial wilt or brown rot caused by *Bacterium solanacearum* E. F. S. produces more or less sudden wilting of the leaves often with large water-soaked and brown areas on the stems. When cut across the vascular bundles are found to be browned somewhat as with Fusarium wilt. It is possible to mistake this disease for bacterial canker. While brown rot is sometimes serious in the South it apparently is of only minor importance north of the latitude of Virginia. It is known to carry on the seed and to remain in the soil for some time and its numerous hosts, both cultivated and wild, have so generally distributed the infection that it is sometimes difficult to escape this disease entirely. In tomato plant fields it is found most abundantly near the low moist edges of the fields bordering timber along branches. It apparently does not usually become very abundant in tomato plant fields except under special conditions. The attack of nematodes probably is a factor in its spread in moist ground.

That this disease may be spread from plant to plant by human agency and cause serious loss was unintentionally demonstrated in 1933 when one of the plant growers requested the Station to test the value of oversize plants that had been topped as compared with the regular market size plant. The oversize plants were taken from a somewhat moist area where they had become too large for shipping and the market size were pulled a little higher up the slope. Topping was done by hand with a weed blade. The purpose of topping was to reduce the size of the plants to fit shipping crates and have a plant that could be handled readily by planting machines. Table I indicates that results were very unfavorable to

TABLE I

LOSS FROM THE SPREAD OF BROWN ROT WHEN TOPPING OVERSIZE PLANTS IN 1933

KIND OF PLANTS	ACREAGE	% PLANTS REMAINING		ACRE YIELDS IN POUNDS
		6-19	9-14	
Topped 10 days before pulling	1/30	30	14	1,960
Topped 1 day before pulling	1/30	36	23	3,255
Oversize, not topped	1/30	97	82	12,530
Market size	1/30	97	89	10,518

topping, not so much because topping retarded the bearing date but because the cutting blade had apparently spread the bacteria of the brown rot disease from a few infected plants to most of the others. While other diseases became serious toward the end of the season, the brown rot was the cause of the early loss of plants.

SEPTORIA BLIGHT. This disease causes spotting of the leaves and stems, the spots being much smaller than those of Macrosporium blight. While Septoria is often quite serious in the heavy market and canning states it is of comparatively little importance in the South. However, since this disease may be carried on the seed or may carry over in the soil, it is a factor in the southern plant growers' disease-control program.

Nematode root knot, formerly much objected to by the northern buyer is not now considered a very serious trouble unless a buyer is in need of an excuse to turn down a shipment of plants. The cold winters in the North tend to hold down the nematode population in the soil.

A resume of the tomato diseases with which the southern plant grower has to deal reveals that most of them can be carried on the seed, many can live from one season to the next in the soil, many also infect similar crops such as Irish potato, tobacco, eggplant, pepper, etc., many are readily spread from plant to plant in the field, some may even be carried by winds from field to field and, lastly, most of them may be spread by human agencies as with tillage tools, by the hands of the plant pullers and handlers, by means of the sorting and packing benches and by contact of plants in shipping crates. Control measures must then require: first, seed from healthy fields; second, seed treatment; third, rotation of crops with no other related plants such as tobacco, Irish potatoes, eggplant and pepper, etc. in the rotation; fourth, spraying of plants; and fifth, general sanitation in handling plants which includes washing of the hands of pullers when changing fields, disinfection of crates, packing benches, etc., with a bluestone or strong soap solution.

EXPERIMENTAL

RESULTS IN 1931

Recognizing the need for further research in the control of tomato plantbed diseases experimental spraying was begun in 1931 in a commercial plant field kindly loaned for the purpose by the Davis Plant Company of Tifton. The greater part of the experiment was located in a section (No. 4) planted February 23 for the Kings Creek Canning Company of Princess Anne, Maryland. The seed of Marglobe variety was reported purchased by the canning company from a well-known seed company and furnished to the plant growers. This

section which contained about seven and one-half acres was chosen because the seed was reported as untreated.

An adjoining section (No. 3) of Marglobe was planted March 4 to Campbell Soup Company seed which was treated by them. The method of treatment was not determined but is believed to have been mercuric chloride 1-3000. Desiring to make a comparison with the untreated Section No. 4, a part of Section No. 3 was sprayed. As this section was planted rather late not so many spray applications could be made before pulling time as on Section 4. The 1931 spray schedule is given in Table II.

These sections had been planted in 16-inch rows with a tractor drilling four rows at a time and planting in a spiral from the center outward. The sprayer was adjusted to fit the four rows planted by the tractor. Thus each treatment made a complete circle about the field, the center being reserved for the check, next encircling the check were the dust plots, encircling the dust was the OXO Bordeaux and last on the outside was the 4-4-50 Bordeaux. Between the dust plots and the OXO Bordeaux plots and between the OXO and 4-4-50 plots four tomato rows were left unsprayed as a protection from drifting of spray and dust. An unsprayed strip was also left around the outside edge. Thus every plot bordered on unsprayed plants.

The first spray application was put on when the first or second rough leaf was starting on the majority of the plants, this being April 2, in Section 4. Sprays were applied with very little variation from schedule. It was thought desirable to run a series of weekly and another of bi-weekly applications to secure some information on the number of applications necessary for disease control. The sprays were applied at pressures between 200 and 250 pounds per square inch. The dust was applied with a hand duster covering one tomato row at a time. As the rough tomato leaves hold dust well it was applied during the middle of the day, a heavy coating being left on the plants.

No spray burn of importance was observed in any plot. The first Macrosporium blight was found April 16 on both cotyledons of an unsprayed plant. A few spots were also found on adjoining leaves of the same and other plants where the disease had spread. By April 22 a good many spots were found on unsprayed plants but the sprayed plants were practically clean. Soon after April 22 the Davis Plant Company began pulling plants for their shipments so that the plants were pretty generally handled by the plant pullers. Men working in the field remarked at this time that the sprayed plants had a much better appearance than the check and dusted plants.

On May 6, 100 plants were pulled from each plot and set out in a field at Tifton and a similar series was set at Experiment, Georgia.

TABLE II

RESULTS FROM SPRAYING TOMATO SEEDLINGS IN 1931

PLOT NO.	SPRAYS	TIMES SPRAYED	SEED TREATED	DISEASE IN SEED BED MAY 9 AND 12		DISEASE IN MATURITY PLOTS SET AT TIFTON, GA., MAY 6			DISEASE IN MATURITY PLOTS SET AT EXPERIMENT, GA., MAY 7	
				No. plants examined	% diseased	% plants infected May 28	Disease June 25		% diseased June 9	% plants lost by July 24 from disease
							On leaves	On stems		
1	4-4-50 Bordeaux, weekly	6	no	800	0.0	0.0	trace	0	0.0	6.5
2	4-4-50 Bordeaux, bi-weekly	3	no	800	0.6	2.2	very light	0	7.3	8.1
3	4-50 OXO Bordeaux, weekly	6	no	800	2.6	3.4	moderate	moderate	5.3	19.4
4	4-50 OXO Bordeaux, bi-weekly	3	no	800	2.9	9.9	moderate	severe	8.3	9.3
5	20-80 copper-lime dust, weekly	6	no	500	11.2	31.5	moderate	very severe	13.5	28.4
6	20-80 copper-lime dust, bi-weekly	3	no	500	12.8	35.2	moderate	very severe	31.0	29.3
7	Check		no	400	42.0	47.4	severe	very severe	22.2	24.0
8	4-4-50 Bordeaux, weekly	4	yes	500	0.0	0.0	trace	0	1.9	4.8
9	Check		yes	500	5.6	7.2	moderate	moderate	13.7	9.5

On May 9 and 12 a close examination of the seedbed plots for diseases was made. Data on the amount of disease found in the seedbed and in the maturity plots at Tifton and Experiment are given in Table II.

The only important disease found in these plots (aside from southern root rot) was Macrosporium blight. This disease was evident in the "maturity" plots early in the season in about the same proportion among the various plots as it was found in the seedbed. Owing to the necessity of setting the several plots somewhat near to each other the disease soon spread to all plots about equally so that only the data secured from early examinations are considered representative. The completeness with which the plots set at Tifton May 6 reflected the conditions in the seedbed is explained by the fact that no rain fell after the plants were set out until June 15 so that there was little chance during this dry spell for the spread of disease.

Through the cooperation of the experiment stations of Maryland, Indiana, and Delaware we were able to have plants from these plots grown to maturity in these states under the supervision of station pathologists, thus making the test under conditions comparable to the usual handling of southern plants. One hundred plants from each plot were sent to each cooperator except as noted otherwise.

In Table III is shown the amount of early blight that developed on southern plants as reported by Manns (17) for Delaware and Hunter for Maryland. The plots sprayed with homemade Bordeaux held up the best of all plots. In Maryland a few plants infected with bacterial canker showed up in plots 1-7 from untreated seed. None appeared in plots 8 and 9 from treated seed of a different lot. Bacterial spot *(Bacterium vesicatorium* Doidge) also appeared in the Maryland plots. Two shipments were sent to Indiana, 50 plants each from plots 1-7 on April 22 and 100 each from plots 1-9 on May 11. Samson reported less early (Macrosporium) blight in the early set plants than in the others. Bacterial canker appeared in all plots, the amounts in each being given in Table III. These three diseases were believed to have carried with the plants.

Summarizing the results of the first year of the experiment it appears that the copper lime dust was not efficient in the control of disease, the OXO Bordeaux gave fair to good control while the homemade Bordeaux gave best results. While the OXO Bordeaux is easy to prepare this can not make up for its slightly poorer control and higher cost. Lacking clean seed or efficient seed treatment, assuming that the soil was disease free, spraying did not give complete disease control although the homemade Bordeaux held down disease markedly considering the proximity of unsprayed plants

and the fact that plant pullers pulled over these plots indiscriminately.

The undoubted superiority of clean seed was brought out in plots 8 and 9 from Section 3. It would seem also that bacterial canker was carried on the seed of Section 4 and was not in the soil, since these two sections were side by side in the same field and most of the canker developed in the plants from the untreated seed of Section 4, the little that appeared in plots 8 and 9 probably having spread from the other plots.

TABLE III

SHOWING BACTERIAL CANKER IN INDIANA AND EARLY BLIGHT IN DELAWARE AND MARYLAND ON SOUTHERN PLANTS IN 1931

PLOT NO.	APPROXIMATE PER CENT BACTERIAL CANKER IN INDIANA	PER CENT BADLY BLIGHTED IN DELAWARE JUNE 29	PER CENT MACROSPORIUM BLIGHT IN MARYLAND			
			ON ARRIVAL		JUNE 22	
			LEAF	STEM	LEAF	STEM
1	40	3.5	0.0	0.0	62	16
2	40	15.8	trace	0.0	94	28
3	40	17.8	2.7	2.7	88	56
4	40	12.1	2.6	5.1	88	50
5	100	14.1	0.0	4.9	86	58
6	100	9.6	2.5	4.9	88	42
7	100	20.7	75.0	7.2	98	70
8	4	-----	0.0	0.0	94	26
9	4	-----	2.8	4.7	96	66

RESULTS IN 1932

A quantity of Greater Baltimore seed was secured from an Indiana firm for our 1932 tests. This was stated to be untreated seed that was saved out untreated when making their regular seed treatments. A field was secured for the experimental plots which so far as could be learned had not previously grown tomatoes, at least not within the preceding 13 years. Owing to the poor results secured in 1931 from copper-lime dust, it was omitted from this year's schedule.

In Table IV is given the schedule of treatments for 1932. The seed treatment material was Semesan Jr. This material was dusted on in such quantity as the seeds would readily hold without too heavy a coating. A slightly thinner stand was secured following seed treatment indicating some treatment injury. The plots were laid out side by side with rows running with the slope so that there was no drainage from one plot to another. They were separated by five feet of bare ground except that the checks were separated 50 feet from other plots and from each other.

The first spray application was made when the second rough leaf was starting on the majority of the plants. Weekly applications were made thereafter. When potato beetles appeared arsenate of lead was added at the rate of two pounds to 50 gallons of Bordeaux, the checks being sprayed with lead alone. It was noted that the

TABLE IV

OUTLINE OF SEED TREATMENT AND SPRAYS APPLIED IN 1932

No. 1.	Seed treated, 6 weekly applications 4-4-50 Bordeaux
No. 2.	Seed treated, 6 weekly applications 4-50 OXO Bordeaux
No. 3.	Seed not treated, 6 weekly applications 4-4-50 Bordeaux
No. 4.	Seed not treated, 6 weekly applications 4-50 OXO Bordeaux
No. 5.	Seed treated, plants not sprayed, check.
No. 6.	Seed not treated, plants not sprayed, check

repellent effect of the Bordeaux and OXO Bordeaux was such that the beetles never became as numerous on plots 1-4 as on the checks. A small amount of spray burn was noted in the 4-4-50 Bordeaux plots but excellent plants were produced in all plots.

On May 12, 100 plants from each plot were set in maturity plots at Tifton and the following day a like series of plants was sent to each of the experiment stations of Indiana, Delaware, and Maryland to be grown and observed under northern conditions. On May 16 another series was set at Experiment, Georgia.

In the seedbed, no diseases were found until after plants were pulled for setting in the field. Shortly thereafter, brown rot was found scattered thinly in most of the plots. Macrosporium blight appeared in the beds about a month after pulling time but the plot from which it started was not determined.

In the field plots at Tifton, southern root rot (*Sclerotium rolfsii* Sacc.) was severe and killed more than half of the plants in all plots. Early in June examination revealed Macrosporium blight starting in the untreated check plot. On July 5 severe stem cankers were found in the untreated check plot while only leaf spots were found in the other plots. There was apparently little difference to be noted in the various sprayed plots.

At Experiment, Macrosporium leaf spot was first observed in plots 4, 5, and 6 on June 13. The examination of June 28 revealed 100 per cent Macrosporium infection in plots 4, 5, and 6 with 50 per cent in plot 3. Plots 1 and 2 were apparently free from disease. No disease other than the leaf spot and a few plants killed by southern root rot was found. All plants later became seriously affected by Macrosporium leaf spots and stem cankers.

From Maryland, Hunter reported that on June 22 there appeared to be no stem canker or leaf spot in any of the plots. On July 6,

however, 40 per cent bacterial canker infection was found in plot 6 (untreated check) considerable in plot 4 (untreated OXO Bordeaux) and some in plot 5 (treated check).

In Delaware, Manns (18) reported that plot 6 developed 47 per cent bacterial canker with only very small amounts in the other plots. Macrosporium and Septoria blights came in slowly, apparently from a local source. The evidence indicates that seed treatment was of value in controlling the bacterial canker. Mary K. Bryan inspected the plots in Delaware and in Maryland and reported substantially the same amounts of bacterial canker as recorded here.

In Indiana, Sampson reported early in August that there was 20 per cent bacterial canker in plot 6, a trace in plot 4, and no diseases of importance in the other plots. The dry summer is credited for the freedom from leaf spots.

According to the reports from the cooperators the evidence supported the conclusion that the bacterial canker disease was carried north with the plants. The writer is unable to account for the fact that no bacterial canker was found in any of the plots in Georgia, either in the maturity plots at Tifton and Experiment, or the seedbed plots at Tifton. Since the field where the seedbed was located had not been in tomatoes or other solanaceous crop for many years the writer is compelled to believe that the original source of infection was the seed. In further support of this assumption it is reported that bacterial canker was quite common in Indiana in 1931, this being the source of the seed used in this experiment in 1932. If the soil had been the source of the canker disease one would expect practically as high a percentage of canker in plot 5 as in plot 6 and surely a great deal more in the other plots than was found. Since some infection can carry inside the seed this would account for the failure of seed treatment to control entirely. If the seed carried the infection two conclusions are possible; either the seed treatment and spraying did not give complete control or the disease was spread by various means from infected plants of plot 6 to the other plots. It is quite probable that both factors may have been responsible for the presence of canker in plots 1-5.

The results of this season's work appear quite favorable both to seed treatment and spraying in view of the relatively small amount of canker in plots 1-5 and the large amount in check plot 6. They also point to the danger of using seed not known to have come from disease-free fields.

Results In 1933

The land secured for the tomato plots in 1933 had been in cotton for the seven years preceding and it is doubtful if tomatoes had ever been grown in this ground before. It was desired this season

to compare plants from known clean seed, from seed bought on the market and from seed of diseased plants. Clean seed was very kindly furnished by Mary K. Bryan of the Bureau of Plant Industry, and the "commercial" seed was purchased from a seed house. These two lots were Marglobe seed. A third lot, which was Greater Baltimore, was saved from our 1932 maturity plots in this experiment. These plots were heavily infected with Macrosporium blight.

In addition, at the request of Miss Bryan, the old 1932 check plot (No. 6), the plants from which developed such a high percentage of bacterial canker that year, was planted to clean seed. It was hoped to learn whether the bacterial canker carried over in the soil from the previous season.

In Table V the handling of the various plots is outlined. Owing to the spray burn in 1932 the strength of the Bordeaux was reduced to 3-4-50. This was the only spray used. The first eight plots were Marglobe variety, and Semesan Jr. dust was used on the seed treatment plots. Plots 9-12 were Greater Baltimore and the seed for the treated plots was treated with Semesan liquid treatment at harvest before the seeds were dried. The same lot of clean Marglobe seed was planted in plots 13 and 14 as was planted in plots 1-4.

All seed treated with Semesan Jr. made a 10 to 15 per cent poorer stand than that not treated. The liquid Semesan treatment on wet, fresh seed gave just as good a stand as the untreated seed. The clean seed, both treated and untreated, gave a poorer stand than the other lots so that some replanting had to be done.

Unfortunately the plots this year were located on upland soil and they suffered severely from an unusually long drought in April and May that lasted nearly five weeks. The plants grew slowly and were very uneven in size. In fact, water was hauled in barrels and plots 1 and 2 which were on the highest ground were watered every other day for nearly two weeks. Plants sent to cooperators were far from ideal.

Five applications of 3-4-50 Bordeaux mixture were made at weekly intervals with pressure, as in other seasons, at 200 to 250 pounds. As there was a little spray burn from the early applications the lime was increased to make a 3-6-50 spray. Late sprays did not burn.

During the drought all lower leaves of the plants dried up and dropped off and there was little encouragement for the spread of diseases. Several examinations, which continued after plants had been shipped to the cooperators, discovered no disease in plots 1-4 except that there was a thin scattering of Cladosporium mold which was found in all of the 12 plots. The Cladosporium came from another planting of tomatoes a short distance from the plots, the plants for which carried the mold from the greenhouse. A single

Macrosporium stem canker was found in plot 6 and two in plot 8 with a trace of Macrosporium blight on a few leaves. In the plots from known infected seed, only tomato mold was found in plot 9. 11 plants with Macrosporium stem cankers and three with leaf

TABLE V

OUTLINE OF SEED TREATMENT AND SPRAYS APPLIED IN 1933. SPRAY MATERIAL 3-4-50 BORDEAUX MIXTURE

Plot 1.	Clean seed, treated Semesan Jr., sprayed 5 times
Plot 2.	Clean seed, treated Semesan Jr., not sprayed.
Plot 3.	Clean seed, seed not treated, sprayed 5 times
Plot 4.	Clean seed, seed not treated, not sprayed.
Plot 5.	Commercial seed, treated Semesan Jr., sprayed 5 times.
Plot 6.	Commercial seed, treated Semesan Jr., not sprayed.
Plot 7.	Commercial seed, seed not treated, sprayed 5 times.
Plot 8.	Commercial seed, seed not treated, not sprayed
Plot 9.	Infected seed, treated Semesan, sprayed 5 times
Plot 10.	Infected seed, treated Semesan, not sprayed
Plot 11.	Infected seed, seed not treated, sprayed 5 times
Plot 12.	Infected seed, seed not treated, not sprayed
Plot 13.	Clean seed, treated Semesan Jr., sprayed 5 times (1932 check plot)
Plot 14.	Clean seed, seed not treated, not sprayed (1932 check plot)

spots were found in plot 10, and one stem canker and a trace of leaf spot in plot 12. The plants had all been pulled from plot 11. The value of Semesan for the control of Macrosporium blight is somewhat doubtful since 11 stem cankers were found in a Semesan treated plot 200 x 10 feet in a season when there was very little possibility of spread.

In plots 13 and 14 (1932 check plot) Macrosporium stem cankers were rather plentiful being more abundant in the untreated and unsprayed plot 14 than in plot 13. The unsprayed plot also developed severe foliage blight which was not serious in plot 13 until some time after spraying had been discontinued. Since the same seed planted here was planted in plots 1-4 which developed no disease, it is plain that the Macrosporium came from the previous year's crop and carried over in the soil.

Plants were sent this year to the experiment stations of Indiana, Maryland, Delaware, New York (Geneva), and Iowa, and to Mary K. Bryan, Bureau of Plant Industry, Washington, D. C. Owing to the uneven development of the plants, all cooperators were not supplied at the same time. The first plants were pulled and shipped May 22 and the last on June 2. To the Iowa Experiment Station were sent 100 plants from each of plots 1-8 and 50 each from plots 9-12; to New York 100 each from plots 1-8; to Delaware 200 each from 1-8; to Indiana 150 each from 1-8 and 50 each from 13 and 14;

to Maryland 100 each from 1-12 and 50 each from 13 and 14; and to the Bureau of Plant Industry, Washington, D. C., 100 each from 1-4, 25 each from 9-12 and 150 each from 13 and 14. In addition, 100 from each plot were set out at Tifton and at Experiment, Georgia.

That the severe drought markedly held down the development of disease is indicated by the reports from the cooperators. In Delaware there was a trace of early blight in all plots but no disease could be traced to the plants as the source. In Indiana no disease developed that appeared to have come with the plants. The sprayed plants looked particularly good. In Iowa, Wilson reported the season very dry and the plants developed no disease except Cladosporium mold which was not important. In Maryland, early blight in the plots apparently came from adjoining fields, the plants probably not being responsible for any disease whatever. In New York, Horsfall reported small amounts of early and late blights and a trace of tomato mold. There appeared to be no evidence that these two blights came with the plants.

Plants from plots 13 and 14, which plots were suspected of harboring bacterial canker, developed no canker at any of the stations or at Washington, D. C., where they were grown in the greenhouse and none appeared in the seedbed or in the plots set at Tifton, Georgia. There was, however, a heavy infection of early blight in these plots.

In the maturity plots set at Tifton plot 13 developed 51 per cent leaf and petiole infection with Macrosporium blight and plot 14 developed 66 per cent on stems, leaves and petioles by July 5. In the other 12 plots there were only three plants with a trace of Macrosporium leaf infection which very probably was air borne from an older patch of heavily diseased tomatoes located 300 feet distant. At Experiment, Georgia, plots 13 and 14 which were located one-fourth mile from the others became heavily infected on leaves and stems with Macrosporium. Plots 1-12 were lightly and evenly infected with the blight which probably came from a nearby older field heavily infected with this disease. No bacterial canker was found.

While the drought in April and May appears to have nullified much of this year's work, there are a few points that were brought out. First, a drought during the growth of the seedlings appears to be as efficient as spraying in keeping down the spread of disease. This appears to be a fortunate circumstance since a moderate drought in early spring is a regular occurrence in south Georgia and years when it does not occur are often disastrous to several other crops. Second, Macrosporium, as was expected, carried over in the soil in plots 13 and 14. Third, results from plots 13 and 14 strengthened the writer's

belief that bacterial canker does not usually carry over from season to season in the soil in south Georgia. Fourth, Semesan apparently is not an efficient control of Macrosporium disease carried on the seed as was shown in plots 9-12.

Results In 1934

The land secured for the 1934 tomato plots had been in oats, corn, and soybeans for the preceding four years. As far as could be learned the last and only time this field was in tomatoes was in 1928 when it grew a crop of plants. A small lot of uncertified seed was secured from each of three different seed houses and all three mixed together. It was hoped thus to make sure of having disease on the seed. Half of the seed was treated with mercuric chloride 1-1000 solution for five minutes and washed 10 times. Only four plots were planned for the regular spraying experiment as described in Table VI. The plots were 380 by 10 feet with six foot alleys between plots. The field was nearly level, the drainage running practically with the rows.

The spray was applied as before with a power sprayer at pressures between 200 and 250 pounds using two nozzles to each row. Owing to the spray burn occurrring in other years following early applications, the first application this year was a 2-3-50 Bordeaux, the others being 3-4-50. Practically no spray burn was observed this year.

As a rule a 1-1000 mercuric chloride solution when applied on dry seed will retard or reduce germination but so far as could be observed there was no difference in the stands secured from treated and untreated seed. The rather low temperature of the treating solution and the wash water may have had something to do with the apparent lack of injury.

TABLE VI

Showing the Seed and Spray Treatment of the Various Plots in 1934

Plot A.	Seed treated, plants sprayed 5 times Bordeaux mixture
Plot B.	Seed treated, plants not sprayed
Plot C.	Seed not treated, plants sprayed 5 times Bordeaux mixture
Plot D.	Seed not treated, plants not sprayed

In 1934 the Georgia state entomologist offered to certify tomato plants for growers who raised their plants in accordance with specified regulations. One of the requirements was that certified seed acceptable to the state entomologist must be used. In connection with this work a number of samples of certified seed was received from growers by Tom O'Neil of the entomologist's office and others were collected by the writer. These were all numbered and planted in

TABLE VII

LIST OF PLOTS PLANTED TO CERTIFIED SAMPLES COLLECTED FROM DEALERS AND PLANT GROWERS AND PLANTED MARCH 27, 1934

PLOT NO.	VARIETY	IMMEDIATE SOURCE WHERE COLLECTED	DEALERS, GROWERS, ETC. OF THE SEED	SEED TREATMENT WHERE KNOWN OR REPORTED
1	Indiana Baltimore	Sec. Indiana Canner's Assoc.		Hgc 12 1-3000
2	Indiana Baltimore	Dr. R. W. Samson Purdue University	Purdue University	Hgc 12 1-3000
3	Marglobe	Tri-State Packers Assn., Easton, Md.		
4	Glick's Pritchard	Glick's Seed Farms, Lancaster, Pa.		
5	Hillborns Selected Globe	Glick's Seed Farms, Lancaster, Pa.		
6	Improved Marglobe	Glick's Seed Farms, Lancaster, Pa.		
7	Marglobe A	D. Landreth Seed Co., Bristol, Pa.		
8	Marglobe B	D. Landreth Seed Co., Bristol, Pa.		
9	Marglobe C	D. Landreth Seed Co., Bristol, Pa.		
10	Break O'Day	D. Landreth Seed Co., Bristol, Pa.		
11	Greater Baltimore	D. Landreth Seed Co., Bristol, Pa.		
12	Pritchard	D. Landreth Seed Co., Bristol, Pa.		
13	Stone	D. Landreth Seed Co., Bristol, Pa.		
14	Landreth Red Rock	D. Landreth Seed Co., Bristol, Pa.		
15	Marglobe	Davis Plant Co., Tifton, Ga.	D. Landreth Seed Co.	Semesan
16	Dean's Pritchard	Davis Plant Co., Tifton, Ga.	R. O. Dean, Federalsburg, Md.	Semesan
17	Indiana Baltimore	Davis Plant Co., Tifton, Ga.	Ia. Can. Co., Vinton, Ia.; Ind. Canners Association	$HgCl_2$ 1-3000
18	Harris' Early Stone (not certified)	Davis Plant Co., Tifton, Ga.	Ia. Can. Co., Vinton, Ia.; Joseph Harris & Co., Coldwater, N. Y.	
19	Greater Baltimore	Davis Plant Co., Tifton, Ga.	Campbell Soup Co., Camden, N. J.	Monohy. $CuSO_4$
20	Pritchard	Davis Plant Co., Tifton, Ga.	Campbell Soup Co., Camden, N. J.	Monohy. $CuSO_4$

TABLE VII—(Continued)

LIST OF PLOTS PLANTED TO CERTIFIED SAMPLES COLLECTED FROM DEALERS AND PLANT GROWERS AND PLANTED MARCH 27, 1934

PLOT NO.	VARIETY	IMMEDIATE SOURCE WHERE COLLECTED	DEALERS, GROWERS, ETC. OF THE SEED	SEED TREATMENT WHERE KNOWN OR REPORTED
21	Marglobe	Davis Plant Co., Tifton, Ga.	Campbell Soup Co. Camden, N. J.	Monohy. $CuSO_4$
22	J. T. D.	Davis Plant Co., Tifton, Ga.	Campbell Soup Co., Camden, N. J.	Monohy. $CuSO_4$
23	Pritchard	Davis Plant Co., Tifton, Ga.	Landreth Seed Co.	Monohy. $CuSO_4$
24	Indiana Baltimore	Bert C. Keithley	Ind. Canners Assoc.	$HgCl_2$ 1-3000
25	Red Rock	Service Plant Co., Omega, Ga.	Landreth Seed Co.	
26	Marglobe	Service Plant Co., Omega, Ga.	Stokes Seed Co., Philadelphia, Pa.	
27	Marglobe	C. E. Grubb, Tifton, Ga.	Stokes Seed Co.	
28	Pritchard	C. E. Grubb, Tifton, Ga.	Edgar F. Hurff, Swedesboro, N. J.	
29	Marglobe	Geo. Coleman Plant Farm, Tifton, Ga.	Landreth Seed Co.	
30	Greater Baltimore	Geo. Coleman Plant Farm, Tifton, Ga.	Stokes Seed Co., Philadelphia, Pa.	Semesan
31	Marglobe	Geo. Coleman Plant Farm, Tifton, Ga.	Campbell Soup Co., Camden, N. J.	Monohy. $CuSO_4$
32	Greater Baltimore	Geo. Coleman Plant Farm, Tifton, Ga.	Van Camp Can. Co., Indianapolis, Ind.	
33	Marglobe	Geo. Coleman Plant Farm, Tifton, Ga.	Stokes Seed Co.	
34	Pritchard	Geo. Coleman Plant Farm, Tifton, Ga.	Campbell Soup Co.	
35	Indiana Baltimore	Geo. Coleman Plant Farm, Tifton, Ga.	Campbell Soup Co.	Monohy. $CuSO_4$
36	Greater Baltimore	Davis Plant Co., Tifton, Ga.	Van Camp Can. Co., Indianapolis, Ind.	
37	Marglobe	P. D. Fulwood, Tifton, Ga.	Edgar F. Hurff, Swedesboro, N. J.	Semesan
38	Bonny Best	P. D. Fulwood, Tifton, Ga.	Edgar F. Hurff, Swedesboro, N. J.	Semesan
39	Greater Baltimore	P. D. Fulwood, Tifton, Ga.	Van Camp Can. Co., Indianapolis, Ind.	
40	Greater Baltimore	Omega Plant Co., Omega, Ga.	Campbell Soup Co., Camden, N. J.	Monohy. $CuSO_4$
41	Marglobe	Omega Plant Co., Omega, Ga.	Campbell Soup Co., Camden, N. J.	Monohy. $CuSO_4$

TABLE VII—(Continued)

LIST OF PLOTS PLANTED TO CERTIFIED SAMPLES COLLECTED FROM DEALERS AND PLANT GROWERS AND PLANTED MARCH 27, 1934

PLOT NO.	VARIETY	IMMEDIATE SOURCE WHERE COLLECTED	DEALERS, GROWERS, ETC. OF THE SEED	SEED TREATMENT WHERE KNOWN OR REPORTED
42	Greater Baltimore (not certified)	Omega Plant Co., Omega, Ga.	Shuttleworth & Mott, Matthews, Ind.	
43	Greater Baltimore	Omega Plant Co., Omega, Ga.	Stokes Seed Co.	
44	Pritchard	Omega Plant Co., Omega, Ga.	Campbell Soup Co.	Monohy. $CuSO_4$
45	Bonny Best	Omega Plant Co., Omega, Ga.	Stokes Seed Co.	Semesan
46	Marglobe	Davis Plant Co., Tifton, Ga.	R. O. Dean, Federalsburg, Md.	Semesan
47	Greater Baltimore	Harrell Plant Farm, Ty Ty, Ga.	Edgar F. Hurff, Swedesboro, N. J.	
48	Greater Baltimore	Harrell Plant Farm, Ty Ty, Ga.	Stokes Seed Co.	
49	Marglobe	Harrell Plant Farm, Ty Ty, Ga.	Stokes Seed Co.	
50	Scarlet Topper (Pritchard) (not cert.)	Harrell Plant Farm, Ty Ty, Ga.	Edgar F. Hurff	
51	Marglobe (Different from N. J. certified lot)	Harrell Plant Farm, Ty Ty, Ga.	Stokes Seed Co.	
52	Marglobe	Harrell Plant Farm, Ty Ty, Ga.	Ferry-Morse Seed Co. Michigan	
53	Ferry's Scarlet Topper (not certified)	Harrell Plant Farm, Ty Ty, Ga.	Ferry-Morse Seed Co. Michigan	
54	Marglobe	D. J. Harrison, Blackshear, Ga.	Edgar F. Hurff, Swedesboro, N. J.	
55	Greater Baltimore	D. J. Harrison, Blackshear, Ga.	Edgar F. Hurff, Swedesboro, N. J.	
56	Marglobe	Emerald Farms, Meigs, Ga.	Edgar F. Hurff, Swedesboro, N. J.	
57	Greater Baltimore	Emerald Farms, Meigs, Ga.	Edgar F. Hurff, Swedesboro, N. J.	
58	Stokes' Master Marglobe	Sims Plant Co., Pembroke, Ga.	Libby, McNeil & Libby, Camden, Del.; Stokes Seed Co.	
59	Indiana Baltimore	Sims Plant Co., Pembroke, Ga.	Ind. Canner's Assoc., Indianapolis,, Ind.	$HgCl_2$ 1-3000
60	Marglobe	Sims Plant Co., Pembroke, Ga.	Clay Webb, Vianna, Md.; Tri-State Packers Assoc., Easton, Md.	

TABLE VII—(Continued)

LIST OF PLOTS PLANTED TO CERTIFIED SAMPLES COLLECTED FROM DEALERS AND PLANT GROWERS AND PLANTED MARCH 27, 1934

PLOT NO.	VARIETY	IMMEDIATE SOURCE WHERE COLLECTED	DEALERS, GROWERS, ETC. OF THE SEED	SEED TREATMENT WHERE KNOWN OR REPORTED
61	Bonny Best	Sims Plant Co., Pembroke, Ga.	Geo. R. Pedrick & Son, Pedricktown, N. J.	
62	Bonny Best	Sims Plant Co., Pembroke, Ga.	Ferry-Morse Seed Co., Michigan	
63	Marglobe	Sims Plant Co., Pembroke, Ga.	Ferry-Morse Seed Co., Michigan	
64	Scarlet Topper (Pritchard)	Sims Plant Co., Pembroke, Ga.	Edgar F. Hurff	
65	Marglobe	Sims Plant Co., Pembroke, Ga.	Libby, McNeil & Libby, Camden, Del.; Landreth Seed Co., Bristol, Pa.	
66	Indiana Baltimore	Sims Plant Co., Pembroke, Ga.	Libby, McNeil & Libby; Ind. Canners Association	
67	Greater Baltimore	Sims Plant Co., Pembroke, Ga.	Edgar F. Hurff	
68	Marglobe	Sims Plant Co., Pembroke, Ga.	Edgar F. Hurff	
69	Pritchard	Sims Plant Co., Pembroke, Ga.	Clay S. Webb, Vianna, Md.	
70	Marglobe	Sims Plant Co., Pembroke, Ga.	Clay S. Webb, Vianna, Md.	

the field along with the spraying experiment. There was a total of 70 samples all but a few of which were supplied as certified seed. Table VII gives the varieties, the person or firm from whom collected and such other information as to the source and treatment of the seed as could be secured. The first 14 samples were secured direct from the seedsmen. This experiment was arranged as a test of the various lots of seed actually in the hands of the planters with the purpose of determining the amount of disease that would develop from them. Since many growers got seed from the same source, there are a good many duplications.

A total of five spray applications was made in the regular spraying experiment, the last application being made May 18. Since statements have been made that Bordeaux on the leaves tends to increase the loss of water from them an attempt was made this year to note if this was of practical importance in transplanting plants

immediately after spraying. The plants therefore were pulled and shipped as soon as possible after the last spray application. On the 19th, plants were sent to Maryland, Delaware, and Indiana, on the 21st the shipment to Iowa was made and on the 22nd plants were pulled to set out at Tifton and at Experiment. There were moderate rains on the 20th and 21st but plants pulled after the rains still carried heavy coats of Bordeaux.

TABLE VIII

SHOWING THE PER CENT OF DISEASED PLANTS IN THE VARIOUS SEEDLING TOMATO PLOTS. THIS INCLUDES THE TOMATO PLANT SPRAY EXPERIMENT AND THE SAMPLES OF CERTIFIED SEED. EXAMINED 5-22-34

PLOT NO.	PLANTS WITH LEAF SPOTS	PLANTS WITH STEM CANKER	TOTAL PLANTS EXAMINED	PER CENT INFECTED
A	1 suspicious	0	500	0
B	5	0	500	1
C	68	0	500	13.6
D	80	0	500	16
1	0	0	206	0
2	1	0	152	0.7
3	1	0	154	0.7
4	0	0	118	0
5	0	0	219	0
6	0	0	111	0
7	0	0	147	0
8	0	0	46	0
9	0	0	264	0
10	0	0	66	0
11	0	0	243	0
12	0	0	93	0
13	0	0	260	0
14	0	0	56	0
15	0	0	200	0
16	0	0	290	0
17	0	0	500	0
18*	0	0	500	0
19	0	0	252	0
20	5	0	368	1.4
21	0	0	375	0
22	0	0	342	0
23	5	1	500	1
24	2	0	500	0.4
25	58	2	410	14.1
26	8	0	500	1.6
27	12	0	486	2.5
28	0	0	27	0
29	5	0	550	0.9
30	30	1	400	7.5
31	1	0	71	1 4
32	6	0	400	1.5
33	3	0	400	0.8

TABLE VIII—(Contniued)

SHOWING THE PER CENT OF DISEASED PLANTS IN THE VARIOUS SEEDLING TOMATO PLOTS. THIS INCLUDES THE TOMATO PLANT SPRAY EXPERIMENT AND THE SAMPLES OF CERTIFIED SEED. EXAMINED 5-22-34

PLOT NO.	PLANTS WITH LEAF SPOTS	PLANTS WITH STEM CANKER	TOTAL PLANTS EXAMINED	PER CENT INFECTED
34	1	0	400	0.3
35	0	0	65	0
36	0	0	400	0
37	0	0	400	0
38	1	0	400	0.3
39	0	0	400	0
40	7	0	225	3.1
41	0	0	92	0
43	1	0	400	0.3
44	18	0	311	5.8
45	47	6	400	11.8
46	7	0	182	3.8
47	39	3	500	7.8
48	17	0	400	4.3
49	2	0	400	0.5
50*	2	0	217	0.9
51	24	0	500	4.8
52	155	many	300	51.7
53*	70	0	300	23.3
54	29	0	225	12.9
55	4	0	294	1.4
56	5	0	228	2.2
57	7	0	400	1.8
58	6	0	173	3 5
59	72	1	431	16.7
60	0	0	8	0
61	2	0	51	3.9
62	0	0	49	0
63	0	0	77	0
64	0	0	23	0
65	5	0	207	2.4
66	8	0	127	6.3
67	7	0	132	5.3
68	1	0	47	2.1
69	11	0	148	7.4
70	4	0	24	16.7

* Not certified.

As soon as plant pulling was finished on May 22 an examination was made of all plots to determine what diseases were present. The results are tabulated in Table VIII. Plots A, B, C, and D are the plots in the spray experiment while the numbered plots are those from the certified seed samples which are described in Table VII. Since some of the samples of certified seed were quite small there

were few plants left after plants were pulled for shipment, which explains the small number of plants examined in some plots. Macrosporium blight was the principal disease found, with the exception that more than half of the spots in No. 52 were bacterial spot (*Bacterium vesicatorium* Doidge) as were also some of the spots found in the adjoining rows.

It is to be noted that this year the seed treatment appears to have been quite effective in the control of diseases since there was found only one leaf spot in the treated and sprayed plot and only one per cent in the plot treated but not sprayed. This compares with 13.6 per cent in the untreated, sprayed plot and 16 per cent in the untreated, unsprayed plot. Apparently, with infection carrying on the seed, spraying alone was ineffective as a control measure. At a later examination on June 2 plot A was holding up well and had few infection spots while the other three plots were quite generally spotted.

The writer wishes to call special attention here to the results from the samples of certified seed as shown in Table VIII. It is noted that in 42 per cent of these plots no disease was found and an additional 14 per cent had less than one per cent of the plants infected. This is a striking comparison with the results secured by Boyd (5) in a similar test in 1929 and discussed earlier in this bulletin. In Boyd's test every lot developed some disease. It appears to the writer, and others have remarked upon it, that there has been considerable improvement in the quality of tomato seed, as regards freedom from disease, in the five years since Boyd's test was made. With several states now certifying seed and Georgia certifying plants the southern plant is becoming more attractive each year.

In Table IX the amount of disease found in the maturity plots at Tifton is shown. The same diseases developing in the seedbed were present also in these plots and the value of the seed treatment is further demonstrated. Outside of the Macrosporium blight and bacterial spot two plants were infected by brown rot and a few by southern root rot.

Besides the four plots in the spraying experiment four certified seed plots were set at Experiment. Results are given in Table X. Here again the plants from the treated seed appear to have remained healthy much longer than the plants from untreated seed, showing that infection did not carry with the plants in any appreciable amount and therefore developed more slowly than in those plots carrying much infection on the plants.

Attention is called to the fact that the check plot D, unsprayed and untreated, had less disease than plot C. This may have been due to the fact that in order to separate plot D from the others it was set in a low spot subject to wash and was flooded soon after

TABLE IX

SHOWING AMOUNT OF DISEASE DEVELOPING IN THE MATURITY PLOTS AT TIFTON, GEORGIA, IN 1934

PLOTS AND TREATMENTS	EXAM. 6-8-34				EXAM. 6-29-34				EXAM. 7-19-34		
	LEAF SPOTTED PLANTS	STEM CANKERED PLANTS	TOTAL PLANTS	TOTAL DISEASED PLANTS	LEAF SPOTTED PLANTS	STEM CANKERED PLANTS	TOTAL PLANTS	TOTAL DISEASED PLANTS	LEAF SPOTTED PLANTS	STEM CANKERED PLANTS	TOTAL PLANTS
A. Seed treated plants sprayed	0	0	94	0	1	0	94	1	Light general infection on A. & B., severe on C. & D., heaviest on D.	very few	94
B. Seed treated plants not sprayed	1	0	96	1	0	1	95	1		very few	93
C. Seed not treated plants sprayed	7	0	88	7	8	5	86	10		many	85
D. Seed not treated plants not sprayed	5	0	73	5	17	3	71	18		many severe	64

setting and most of the plants covered or nearly covered with mud. No doubt this covered most of the lower infected leaves and stem cankers and thus delayed the spread of diseases.

From the small amount of disease on the plots from certified seed it appears doubtful that much infection carried on the seed. The amount present could have spread from other plots in the seedbed or after setting in the field.

Although the plots at Experiment were kept under close observation, no more wilting after setting was observed in the sprayed plots than in the unsprayed. In fact, plot A which was sprayed, was set out without presoaking the roots while the others were placed in water until plot A was set. No water was used about the plants as the ground was in good moisture. Cooperating stations reported results quite similar to these.

In Delaware there was a trace of Macrosporium leaf blight in all plots in the spray experiment but more in the check plot than in the others. Thirty-five lots of plants from the certified seed plots were set in Delaware. Early and late blights were severe late in the season but were believed not to have come with the plants from the South.

In Maryland no disease was found until July 16, when there was a very light infection of early blight. Disease conditions in the four plots from certified seed lots were similar to those in the spray experiment. The dry weather during the first half of the season made it impossible to draw conclusions from this season's work.

In Indiana the season was dry and very little disease developed. No disease appeared on the plants which could be traced either to the plant source or to the seed. The season in Iowa was unusually dry. The plants were very vigorous and did well, no disease showing up until July 24 when Septoria blight first appeared. It was evidently of local origin. Sprayed plants on arrival appeared, if anything, more vigorous than the unsprayed. Some fusarium wilt was found but its source was not determined. The outstanding feature of the southern plants was their sturdiness when transplanted. The season was so dry that the results on the value of seed treatment and spraying were inconclusive.

Summarizing the results for 1934 it appears that seed treatment is of more value than spraying but that the two combined are better than either alone. The presence of Bordeaux spray on the leaves of tomato plants apparently is of no practical importance as a cause of wilting after setting in the field. It is also noted that a dry spring in the North was quite valuable in holding down diseases until the plants reached maturity.

TABLE X

SHOWING AMOUNT OF DISEASE DEVELOPING IN THE MATURITY PLOTS AT EXPERIMENT, GEORGIA, IN 1934

PLOT NO.	TREATMENT, SEED, SOURCE, ETC.	JUNE 11				JULY 12 AND 16				
		LEAF SPOTTED PLANTS	STEM CANKERED PLANTS	TOTAL PLANTS	TOTAL DISEASED PLANTS	LEAF SPOTTED PLANTS	STEM CANKERED PLANTS	TOTAL PLANTS	TOTAL DISEASED PLANTS	PLANTS WITH FRUIT SPOTS
A	Seed treated mercuric chloride, plants sprayed Bordeaux	0	0	101	0	15	1	99	15	0
B	Seed treated mercuric chloride, plants not sprayed	2	1	92	2	61	3	92	61	0
C	Seed not treated, plants sprayed Bordeaux	49	3	96	49	96	28	96	96	3
D	Seed not treated, plants not sprayed	38	0	105	38	90	14	96	96	1
11	Greater Baltimore D. Landreth Seed Company	2	0	84	2	61	4	76	61	
13	Stone, D. Landreth Seed Company	6	0	95	6	81	0	94	81	
15	Marglobe, D. Landreth Seed Company	19	0	95	19	88	5	91	88	
19	Greater Baltimore Campbell Soup Company	2	0	104	2	97	0	101	97	

TOMATO SEED TREATMENT

Recommendations for the treatment of tomato seed with chemicals should be made with considerable caution because those treatments that appear to be effective in disinfecting the seed usually cause some injury. Whether or not this injury will reduce the stand of plants depends upon several factors, some of which are temperature both at the time of treatment and at the time of germination, soil moisture, organic matter in the soil, etc. Horsfall (12) secured very good results in the control of damping off in greenhouses and plant beds in New York State with monohydrated copper sulphate dust. However, in south Georgia fields where the moisture supply can not be controlled, and the soils are sandy, serious reduction in stand sometimes results from the use of this material when a drought occurs at planting time. Red copper oxide, also recommended by Horsfall, (13) is another dust treatment being used in some sections. The writer has had very little experience with this material.

In the two years when Semesan Jr. was used in the experimental plots, some reduction in stand occurred. This material has, we understand, been displaced by Improved Semesan Jr. The latter has not been tested on tomato seed by the writer. Soaking the seed in mercuric chloride (corrosive sublimate), one part to 3,000 parts of water, is a treatment now in use by many seed producers but there is some doubt as to its efficiency in the control of diseases. It apparently causes little or no injury to the germinating seed.

The 5-minute soak in a 1-1000 solution of mercuric chloride is a standard treatment for many kinds of seeds. There is, however, some risk from using this treatment, especially on dry seed. When used on the fresh damp seed direct from washing at the time of saving the seed there is a marked reduction in injury compared with that resulting from its use on dried seed. Thorough washing of the seed after treating with mercuric chloride is commonly recommended but in many tests in this laboratory there appeared to be little advantage in washing if the seed was dried at once.

Semesan is used extensively in the treatment of tomato and other vegetable seeds. In the one season when it was used in the field it apparently did not give complete disease control although aided by a severe drought. Laboratory tests of this material indicate that it sometimes reduces germination.

Blood (2) secured control of bacterial canker by fermenting the seed in the pulp from three to six days at time of harvest. There was also some reduction in percentage of germination when the seed was fermented The writer got an average germination of 94.5 per cent with unfermented seed, 91.6 per cent with seed fermented two days and 81.8 per cent when it was fermented six days. Whether or

not seed fermentation at harvest will be a valuable method of disease control remains to be demonstrated. There appears to be no general rule among seed producers in regard to fermentation, some cleaning the seed without fermentation while others ferment from one to several days, the time being largely a matter of convenience.

SANITATION

There are a number of sanitary precautions that should be observed when growing and handling plants. Laxness in this respect may spread disease in certified plants. Some of these sanitary measures are listed below.

1. Seed planters, after having planted untreated seed and before planting treated seed, should be washed out with a solution of one pint of formaldehyde in six gallons of water. Cover an hour or two, then dry thoroughly before using. Stray seeds, seed pieces, trash, etc., from untreated seed lots can carry disease to clean seed.

2. Clean, treated seed should not be planted adjoining or near to fields planted to other seed lots. Many diseases are easily spread by wind. Fields planted with clean seed should be at least one-half mile from other fields.

3. Certified treated seed should not be kept in the same storeroom with other lots. This amounts to placing clean seed in the midst of a disease environment. There is danger of a few scattered seeds spreading disease.

4. If growers who handle certified plants can see their way clear to handle no uncertified plants they will have greatly simplified their work, can more easily produce clean plants and will safeguard themselves from any suspicion of mixing uncertified with certified plants.

5. Sorting and packing benches, hands of the workers, etc., should be washed with hot, strong soapy water after handling plants from untreated seed and before handling certified plants. Fungus spores may be rubbed onto the hands of the workers, onto the parts of the sorting benches and even pieces of diseased leaves may be left on the benches. When plants, eligible for certification, are handled by contaminated hands on contaminated benches where dirt and pieces of diseased plants are scattered about there is much danger of spreading disease on the clean plants.

6. After leaving another field to start pulling plants in a field grown for certification the puller's hands should be washed with soap and water and crates in which plants are hauled to the packing house should be dipped in a solution of one pound of bluestone in six or eight gallons of water. Allow crates to dry before placing plants in them.

DISCUSSION

The early season and weather conditions in south Georgia combine to make it possible to produce a more hardy tomato plant earlier in the season and at a lower cost than can be done in the northern tomato growing states. In the early years of the business there apparently was little done about securing disease-free seed and producing disease-free plants. As complaints became frequent, both seed and plant producers sought methods of improving their products. A comparison of a test of seed samples made by Boyd in 1929 with a similar test made by the writer in 1934 indicates a great improvement in the production of disease-free seed.

Experiments discussed in this bulletin and covering four plant-growing seasons have indicated methods for producing disease-free plants. A good method of seed treatment appears to have much greater influence on the production of clean plants than spraying. If the seed treatment is effective in destroying the seed infection and the field planted is free of diseases, then the only function of spraying is to protect from contamination by disease spores carried through the air from other diseased fields. However, since comparatively mild seed treatments must be used to avoid injury, spraying is a very necessary part of the program of disease control.

Five and six spray applications have been made in these experiments but it is probable that with other control measures such as the use of certified seed, seed treatment, rotation of fields, etc., three applications of Bordeaux mixture will be sufficient. Young plants seem to be more susceptible to spray burn than older ones. Sometimes, also, rank-growing sappy plants are easily burned. The use of a 2-3-50 Bordeaux for the first application appeared to reduce the amount of early burn.

Although weather conditions, both in Georgia and in the cooperating northern states, affected the results, the data on the whole indicate that a combination of seed treatment, crop rotation, and efficient spraying will control most seed-borne diseases. No evidence was obtained that pointed to the soil of south Georgia as a source of disease on plants sent north when proper rotation was practiced. On the other hand the evidence indicated that the seed is frequently the carrier of diseases. A possible exception to this was the appearance of brown rot in 1932. This disease, however, appears not to cause much loss in northern states. Fusarium wilt has not entered into this control program because its control depends largely on resistant varieties and it is perhaps as much a problem in one state as in another.

Bacterial canker which appeared in two years out of the four was much more severe in the check plots and dusted plots than in the

others. If allowance is made for some spread during the handling of the plants it may be said that this disease was reasonably well controlled, considering the fact that it may be carried inside the seed where it is not reached by seed treatment. No proof was obtained that it carried over from season to season in south Georgia soil.

It is a fortunate circumstance that it is usual for a moderate drought to occur in the plant growing section during the plant season. Even seed known to be infected has produced a high per cent of healthy plants in a more than usually dry spring.

No evidence was secured that would indicate that the presence of Bordeaux mixture on the leaves of transplanted plants was of any practical importance as a cause of wilting after transplanting. It is believed that spray material on the leaves of shipped plants offers some protection against the spread of disease from plant to plant in transit.

RECOMMENDATIONS

It is recommended that three applications of Bordeaux mixture be applied to tomato plants, the first to be made when the first and second rough leaves are developing, the others to follow at intervals of about two weeks. In order to avoid burning a 2-3-50 Bordeaux is recommended for the first application, the later ones to be 3-4-50. When beetles begin to appear two pounds of arsenate of lead may be added to each 50 gallons of Bordeaux. This should always be added after the Bordeaux is mixed. Since Bordeaux is a repellent to insects there is less trouble from beetles on Bordeaux sprayed plants than on unsprayed.

It is necessary to use a power sprayer and apply the spray material under not less than 200 pounds constant pressure using two nozzles to each plant row with the spray directed from each side rather than from the top. Top spraying does not give good underleaf coverage. One good application with a nozzle on each side of each row will give better coverage than three applications with one nozzle to a row directed from above. The arrangement of the nozzles should be staggered so that the two nozzles of a row do not spray directly against each other. The sprayer should be drawn at about the speed at which a horse walks. Higher speeds require more nozzles and higher pressures. Nozzle discs should be replaced as the holes are worn too large.

Hard and fast recommendations for the treatment of tomato seed are difficult to make. A combination of several operations may be the solution of the problem of the control of seed-borne diseases. This includes: first, the saving of seed from healthy plants, which suggests certified seed; second, care in handling seed to avoid contamina-

tion by contact or mixing with other seed lots, used containers, etc.; and third, seed treatment by soaking the damp seed at harvest time for five minutes in a 1 to 3,000 solution of mercuric chloride (corrosive sublimate). This is one tablet to three pints of water. This solution may also be used with safety on dry seed. It is not claimed that 1 to 3,000 mercuric chloride will give 100 per cent control of infection on the seed but it does not injure the seed and for that reason is recommended in preference to more drastic treatments. Care must be taken to dry the seed thoroughly before rebagging or it may heat. The bags must also be treated in the same solution to avoid recontamination of the seed. Do not use metal containers when treating with mercuric chloride as metal weakens the solution. Use earthenware, glass or wood. Remember that this material is a deadly poison and must be handled accordingly.

The growing of tomato plants in a field following a tomato crop the year before is absolutely to be avoided. Two or three years should elapse after any related crop such as tomato, Irish potato, tobacco, pepper, eggplant, etc., has been grown before tomato plants are grown. In addition tomato plants should not follow a crop that is very susceptible to nematode root knot.

HOW TO MAKE BORDEAUX MIXTURE

There are in use two methods of making Bordeaux mixture, the stock solution and the "instant" methods. The standard Bordeaux formulae are based on the use of quick, or stone, lime and if hydrated lime is used a third more is required to equal the stone lime. However, in this description the weights refer to actual weights of hydrated lime. This is done to avoid confusion and because good stone lime is hard to secure in south Georgia.

Stock Solution Method. By the stock solution method, strong stock solutions of copper sulphate (bluestone) and of hydrated lime are prepared in separate barrels. One pound of bluestone for each gallon of water is dissolved in one barrel while in the other the same proportions of lime and water are dissolved. Thus, when using this stock solution to make a spray mixture each gallon of stock solution represents one pound of bluestone or of lime according to the one being used.

Bluestone must be hung in a cloth bag in the upper part of the water for several hours or it will not readily dissolve. The lime may be stirred into the water and is ready for use as soon as thoroughly mixed with the water. These stock solutions will be all right for use for many weeks if kept well covered so that they will not become stronger by loss of water in the hot sun or weaker from rainwater. The stock solutions, especially the lime, must be well stirred before using.

In addition to the stock-solution barrels two more dilution barrels or tanks must be provided. For large operations all four barrels are usually mounted on a high platform so that the sprayer tank may be filled by gravity flow. Let us suppose we are making up 100 gallons of a 3-4-50 mixture. Remember that the first figure stands for pounds of bluestone, the second for pounds of hydrated lime and the last for gallons of water. Dip six gallons of stock bluestone solution into the bluestone dilution tank and add enough water to make 50 gallons, that is, 44 gallons. Next dip eight gallons of the stock lime solution into the lime-dilution tank and add 42 gallons of water to make 50 gallons of dilute lime solution. These two dilution tanks empty by gates opening into a common pipe or trough that carries them both together simultaneously to the sprayer tank. Do not open these gates until the dilutions are ready.

The stock solutions must never be combined until after they are diluted to the required amounts. Then they must both be run into the sprayer tank simultaneously and at as nearly as feasible equal rates of flow, the two streams merging with each other as they enter the sprayer. The agitator in the sprayer tank must be running while the tank is being filled and for a short time afterwards. Both dilution tanks should become empty at the same time. If the lime is a little slower than the bluestone it is all right but the bluestone should not be the last to empty.

If potato beetles are to be poisoned, add four pounds of arsenate of lead to this 100 gallons of spray liquid. Stir the lead into a small amount of the Bordeaux in a bucket to avoid lumping, then wash into the tank while the agitator is running. Apply as soon as made.

It is necessary to follow these directions closely as variations from them may result in burning of plants. Always be sure that the hydrated lime is fresh. Lime that has lain in the warehouse over winter is likely to be too old. Old lime not being able to combine properly with the copper sulphate may be the cause of severe burning. In addition to burning it will clog the nozzles causing delays and poor work. If the stock solutions have evaporated down very much it will not be possible to know the actual amounts of materials being used. New stock solutions should be made if this is the case.

Instant Bordeaux. Instant Bordeaux has been recommended as a method that does not require a series of tanks on a high platform and is therefore adapted for use when the place of operation is changed frequently. This method has been blamed as the cause of burning of plants. However, when made up strictly according to the directions for instant Bordeaux there should be no more burning than by the stock solution method. The writer has used the two methods for several years and secured as good results by one method as by the other.

For instant Bordeaux it is necessary to use finely powdered bluestone, known in the trade as "snowform" bluestone. It is about like granulated sugar. The lime should be what is known as chemical hydrated lime. Both of these may be purchased from spray supply houses. This lime is very fine and smooth and when using it the nozzles may be as clean at the end of the day as at the beginning.

To make 100 gallons of 3-4-50 instant Bordeaux, weigh out six pounds of snowform bluestone and place on the screen in the top of the sprayer tank before any water is added to the tank. Whether the tank is filled by the engine with a refiller hose, by a hose from a faucet or by means of buckets, all of the water must be poured over the bluestone in the strainer, dissolving and washing it into the tank. The agitator in the tank should be running all the time.

The snowform bluestone is dissolved in three to five minutes and it takes about that time to fill the tank. Never use coarse bluestone as it dissolves slowly and will not all be dissolved when the lime is added. This is likely to result in free copper sulphate in solution causing burning. If the bluestone appears too coarse to dissolve readily sift through window screen to remove coarse particles. These directions are for use with a power sprayer. For other sprayers it is necessary to dissolve the bluestone in a few gallons of water beforehand, then dilute in the tank.

When the bluestone is dissolved and the sprayer tank is filled to about 85 or 90 gallons weigh out eight pounds of chemical hydrated lime and mix to a very thin paste in water. With the agitator running vigorously add this lime paste to the weak bluestone solution in the sprayer tank and add enough water to make up to 100 gallons, running the agitator for a few minutes after the lime is added. Arsenate of lead may now be added as described for the first method. The mixture should not be allowed to stand but must be applied at once.

The advantage of the instant method is that Bordeaux may be quickly and easily made up anywhere with the aid of only a few buckets and a pair of scales. The snowform bluestone and chemical hydrated lime may be weighed out in paper bags the day before starting to spray. Do not expose lime used in making Bordeaux to air or moisture more than necessary.

A few warnings are in order here. If the Bordeaux after mixing is not of a rich sky blue color but has a greenish cast there is something wrong. Well made Bordeaux does not appear curdled and will not settle much for hours or perhaps days. Carelessness in making Bordeaux can be quite costly. If the nozzles clog frequently and the water used carried no trash, it is likely that the lime is poor or old. In cool weather Bordeaux may be allowed to

stand a few hours without injury but standing is to be avoided as much as possible in hot weather.

SUMMARY

The development of the tomato plant business in the South is taking disease control measures out of the hands of a multitude of market gardeners and placing them in the hands of a small number of plant specialists.

Some of the important tomato diseases together with the ways in which plants may become exposed to attack are briefly described.

The seed which is produced in intensive market sections in the North appears to be the carrier and principal source of most of the diseases found on southern plants.

The usual April-May drought is a factor aiding in the control of plantbed diseases.

The fungus causing Macrosporium blight winters over in the soil. Disease-free seed planted in soil where tomatoes had not grown previously produced plants free of blight while some of the same seed in soil that grew plants the year before produced blighted plants.

In two tests bacterial canker did not winter over in south Georgia soil.

Certified seed lots in 1934 appeared to be much more free of diseases than was true of seed on the market as late as 1929.

The treatment of tomato seed in a 1-3000 solution of corrosive sublimate for five minutes is recommended.

A 2-3-50 Bordeaux spray applied when the second rough leaves are starting followed by applications of a 3-4-50 mixture at about two-week intervals is recommended.

Seed treatment is more valuable for disease control than spraying.

The presence of Bordeaux spray on the plants was of little importance as a cause of excessive wilting of newly set plants.

Sanitary measures to aid in disease control are suggested.

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